CLAIMS

1. A system (120) comprising:

a first sensor (205) configured to detect movement of a vessel (100) and generate a first signal representing the vessel (100) movement;

a second sensor (210) configured to detect movement of a cable (115) and generate a second signal representing the cable (115) movement;

an actuator (215) configured to dampen a force applied to a payload (110) during a force event, wherein the force event is at least partially caused by the movement of the vessel (100) and the cable (115); and

a controller (220) configured to identify the force event based at least in part on the first and second signals, and wherein the controller (220) is configured to control the actuator (215) during the force event to substantially dampen the force applied to the payload (110).

2. A system (120) as set forth in claim 1, wherein the actuator (215) is configured to rotate, and wherein the controller (220) is configured to control an angular displacement of the actuator (215) during the force event.

3. A system (120) as set forth in claim 2, wherein the actuator (215) includes a winch (310) configured to rotate and change an effective length of the cable (115) during the force event.

4. A system (120) as set forth in claim 1, wherein the actuator (215) is configured to change a distance (410) between a first sheave (305) relative to a second sheave (405) during the force event.

5. A system (120) as set forth in claim 4, wherein the actuator (215) is configured to increase the distance (410) between the first sheave (305) and the second sheave (405) to increase an effective length of the cable (115) and decrease the distance (410) between the first sheave (305) and the second sheave (405) to decrease the effective length of the cable (115).

6. A system (120) as set forth in claim 1, wherein the controller (220) is configured to generate a control signal based at least in part on the first signal and the second signal, and wherein the controller (220) is configured to control the actuator (215) using the control signal.

7. A system (120) as set forth in claim 1, wherein the controller (220) is configured to predict at least one of the movement of the vessel (100) and the movement of the cable (115), and wherein the controller (220) is configured to control the actuator (215) based at least in part on the predicted movement.

8. A system (120) as set forth in claim 7, wherein the controller (220) is configured to predict the movement of at least one of the vessel (100) and the cable (115) based at least in part on a sliding mode control technique.

9. A system (120) as set forth in claim 1, wherein the actuator (215) includes a hydraulic cylinder (415).

10. A method comprising:

detecting movement of a vessel (100) relative to a payload (110);

detecting movement of a cable (115) relative to the payload (110);

identifying a force event based on the movement of the vessel (100) and the cable (115), wherein the force event causes a force to be applied to the payload (110) via the cable (115); and

controlling an actuator (215) during the force event based at least in part on the detected movement of the vessel (100) and the cable (115) to dampen the force applied to the payload (110).

11. A method as set forth in claim 10, wherein the actuator (215) is configured to rotate, and wherein controlling the actuator (215) includes controlling an angular displacement of the actuator (215) to change an effective length of the cable (115) during the force event.

12. A method as set forth in claim 10, wherein controlling the actuator (215) during the force event includes controlling the actuator (215) to change a

distance (410) between a first sheave (305) and a second sheave (405) to change an effective length of the cable (115) during the force event.

13. A method as set forth in claim 10, further comprising generating a control signal based at least in part on the detected movement of at least one of the vessel (100) and the cable (115), and wherein controlling the actuator (215) includes controlling the actuator (215) using the control signal during the force event.

14. A method as set forth in claim 10, wherein controlling the actuator (215) includes:

predicting the movement of at least one of the vessel (100) and the cable (115); and

controlling the actuator (215) during the force event based at least in part on the predicted movement of at least one of the vessel (100) and the cable (115).

15. A method as set forth in claim 10, wherein the payload (110) is stationary relative to a seabed (125), and wherein at least one of detecting movement of the vessel (100) and detecting movement of the cable (115) includes detecting movement relative to the seabed (125).

Claims:

1. A method of dampening force applied to a payload secured to a vessel, the method comprising:

detecting one of a pitch, heave, and roll movement of the vessel relative to a payload and generating a first signal representing the detected movement of the vessel with a first sensor;

detecting a movement of a cable relative to the payload and generating a second signal representing the detected movement of the cable with a second sensor;

identifying a force event based on the movement of the vessel and movement of the cable, wherein the force event causes a force to be applied to the payload via the cable;

controlling an actuator during the force event based at least in part on the detected movement of the vessel and the detected movement of the cable to dampen the force applied to the payload; and

generating a control signal, with the controller, based at least in part on the first signal and second signal, wherein generating the control signal based at least in part on the first signal and second signal includes:

estimating, via the controller, a movement of at least one component disposed on the vessel based at least in part on the first signal and generating a first output signal representing the movement of the at least one component;

generating, via the controller, a resultant signal based on the first output signal and an operator command representing a commanded movement of the vessel, the resultant signal representing an adjustment to an effective length of the cable sufficient to substantially attenuate the movement of the vessel with respect to the payload;

generating, via the controller, a second output signal based at least in part on the second signal, the second output signal representing an adjustment to the effective length of the cable sufficient to substantially attenuate the movement of the cable with respect to the payload; and

calculating, via the controller, a summation of the resultant signal and the second output signal, wherein the control signal is defined by the summation of the resultant signal and the second output signal, such that the control signal represents an adjustment to the effective length of the cable sufficient to substantially dampen the force applied to the payload as a result of the movement of the cable with respect to the payload and the movement of the vessel with respect to the payload.

2. The method set forth in claim 1, wherein the actuator is configured to rotate, and wherein controlling the actuator includes controlling an angular displacement of the actuator to change an effective length of the cable during the force event.

3. The method set forth in claim 1, wherein controlling the actuator during the force event includes controlling the actuator to change a distance between a first sheave and a second sheave to change an effective length of the cable during the force event.

4. The method set forth in claim 1, wherein controlling the actuator includes:

predicting the movement of at least one of the vessel and the cable; and

controlling the actuator during the force event based at least in part on the predicted movement of at least one of the vessel and the cable.

5. The method set forth in claim 1, wherein the payload is stationary relative to a seabed, and wherein at least one of detecting movement of the vessel and detecting movement of the cable includes detecting movement relative to the seabed.

6. The method of claim 1 wherein controlling an actuator during the force event based at least in part on the detected movement of the vessel and the detected movement of the cable to dampen the force applied to the payload further includes:

transmitting the control signal, via the controller, to the actuator configured to adjust the effective length of the cable;

commanding, via the controller, the actuator to adjust the effective length of the cable during a force event based on the control signal to thereby dampen the force applied to

the payload as a result of the movement of the cable with respect to the payload and the movement of the vessel with respect to the payload.

7. The method of claim 6 further comprising modifying the control signal and generating a modified control signal, wherein modifying the control signal further includes:

predicting the movement of at least one of the vessel with respect to the payload and the cable with respect to the payload based at least in part on a sliding mode control technique; and

controlling the actuator during the force event based at least in part on the predicted movement of at least one of the vessel and the cable.

8. The method of claim 1 wherein generating the second output signal further includes:

applying an integral force feedback algorithm, such that the integral force feedback algorithm considers each of the second signal, an average tension of the cable, a mass of the cable, and a buoyancy factor.

9. A method comprising:

detecting, via a first sensor, a movement of a vessel with respect to a payload caused by a first force and returning a first signal to a controller representing the movement of the vessel;

detecting, via a second sensor, a movement of a cable with respect to the payload caused by a second force and returning a second signal to the controller representing the movement of the cable;

estimating, via the controller, a movement of at least one component disposed on the vessel based at least in part on the first signal and generating a first output signal representing the movement of the at least one component;

generating, via the controller, a resultant signal based on the first output signal and an operator command representing a commanded movement of the vessel, the resultant signal representing an adjustment to an effective length of the cable sufficient to

substantially dampen the force applied to the payload as a result of the movement of the vessel with respect to the payload;

generating, via the controller, a second output signal based at least in part on the second signal, the second output signal representing an adjustment to the effective length of the cable sufficient to substantially attenuate the movement of the cable with respect to the payload;

generating a control signal, via the controller, the control signal representing an adjustment to the effective length of the cable sufficient to substantially dampen the force applied to the payload as a result of the movement of the cable with respect to the payload and the movement of the vessel with respect to the payload, such that the control signal is defined as a summation of the resultant signal and the second output signal;

transmitting the control signal, via the controller, to an actuator configured to adjust the effective length of the cable to compensate for the movement of the vessel with respect to the payload and the movement of the cable with respect to the payload;

commanding, via the controller, the actuator to adjust the effective length of the cable during a force event based on the control signal to thereby dampen the force applied to the payload as a result of the movement of the cable with respect to the payload and the movement of the vessel with respect to the payload; and

wherein the payload is secured to the vessel via the cable and the payload is disposed on a seabed and is stationary with respect to the seabed.

10. The method of claim 9 further comprising modifying the control signal, via the controller, wherein modifying the control signal further includes:

predicting the movement of at least one of the vessel with respect to the payload and the cable with respect to the payload based at least in part on a sliding mode control technique; and

controlling the actuator during the force event based at least in part on the predicted movement of at least one of the vessel and the cable.